International Civil Aviation Organization

DGP-WG/06-WP/49
13/10/06

WORKING PAPER

DANGEROUS GOODS PANEL (DGP)
MEETING OF THE WORKING GROUP OF THE WHOLE

Beijing, China, 25 October to 3 November 2006

Agenda Item 2: Development of recommendations for amendments to the *Technical Instructions for the Safe Transport of Dangerous Goods by Air* (Doc 9284) for incorporation in the 2009/2010 Edition
2.8: Part 8 — Provisions Concerning Passengers and Crew

EXCEPTIONS FOR FUEL CELL SYSTEMS AND CARTRIDGES CONTAINING BUTANE CARRIED BY PASSENGERS AND CREW

(Presented by R. Richard)

SUMMARY

This paper presents leakage-rate data related to Butane fuel cell systems and cartridges as authorized in the IEC PAS 62282-6-1. The DGP-WG is requested to consider the provisions for fuel cell systems and cartridges containing Butane in Part 8;1.1.2.

Action by the DGP-WG is in paragraph 2.

1. INTRODUCTION

1.1 AT DGP/20, amendments to Part 8;1.1.2 were adopted to incorporate a provision allowing passengers and crew to carry small fuel cell systems and spare fuel cell cartridges aboard aircraft under certain conditions. The DGP considered numerous types of fuels that could be incorporated in these systems and cartridges, and the necessary criteria for inclusion as a passenger exception. The report of DGP/20 (DGP/20-WP/93 paragraph 2.11) provides a detailed account of the panel's decisions regarding this topic. The panel ultimately adopted conditions for passenger exceptions for systems and cartridges containing methanol, formic acid, and butane that will be published in the 2007-2008 edition of the ICAO TIs.

1.2 Members agreed that two fundamental principles should be applied for a fuel cell system or cartridge to be considered for inclusion as a passenger exception in Part 8;1.1.2:

a) the fuel could not be accepted for a passenger exception if the substance was not already acceptable in the TIs for transport as cargo on a passenger-carrying aircraft; and

b) compliance with the detailed requirements of IEC specification PAS 62282-6-1 could be used as one of the criteria for determining acceptability of a fuel cell system or cartridge.

1.3 The panel considered these principles, comparisons to existing authorizations for similar articles, and other appropriate conditions before agreeing to include the three fuel cell technologies in the passenger exceptions based on the information available at that time. The panel decided that fuel cell cartridges containing butane could be described under UN 2037 Gas Cartridges (flammable); therefore, the cartridges could be considered for a passenger exception. While in practice we would expect that the fuel cell cartridges would currently meet the requirements of P203, this is not explicitly indicated in the TIs. Since the last meeting, additional review has resulted in new information becoming available indicating that the passenger exception provisions incorporated for butane may require further consideration. The IEC specification PAS 62282-6-1 provides detailed provisions for fuel cell system and cartridge design type requirements and testing. At present, the IEC specification that addresses the design, testing and construction requirements for these articles serves as the basis for the agreed passenger exception. Annex F of the specification contains requirements specific to Butane. Of particular interest is section F.3.31 which specifies the acceptable leakage rate:

F.3.31 **Impermissable leakage**. When this PAS is used in conjunction with this annex, release of fuel that results in one or a combination of the following situations that are deemed unsuitable:

a) fuel vapour in air mixture in excess of 25% of the lower flammability limit (LFT) beyond a 10 cm distance from the micro fuel cell;

b) fuel vapour in air concentration in excess of the lower of the TLV or MAK occupational exposure limits as indicated on the International Chemical Safety Card (ICSC)

c) **fuel vapour leakage in excess of 0.9 g/h**

Note: This equates to the highest leak rate that will not support a flame and is less than the 1.9 g/h leak rate necessary to achieve the TLV of 800 ppm in a 1 cubic meter chamber with 1 air change per hour.

1.4 The appendix to this working paper provides the calculated leak values for a given number of cartridges in an enclosed volume representative of an aircraft passenger cabin overhead bin based on the leakage rate of 0.9 grams/hr. These are basic calculations to determine if additional review is necessary; therefore, the calculations do not take into account air changes or ventilation. The calculations also use the entire air volume within a given compartment, they do not factor in a reduced overall air volume based on the presence of other cargo or baggage in an overhead bin.

a) Considering a volume of 10 ft^3 (to represent an overhead storage bin) and 3 Butane fuel cell cartridges authorized by the passenger exception, the 25% LEL limit

prescribed in the IEC specification is reached after approximately 1-1/4 hours and the actual LEL after approximately 5 hours.

b) Considering a volume of a 747 cargo bay (2 400 ft^3) and 1 000 Butane fuel cell cartridges transported as cargo, the 25% LEL limit prescribed in the IEC specification is reached in less than 1 hour and the actual LEL is reached just after 3 1/2 hours.

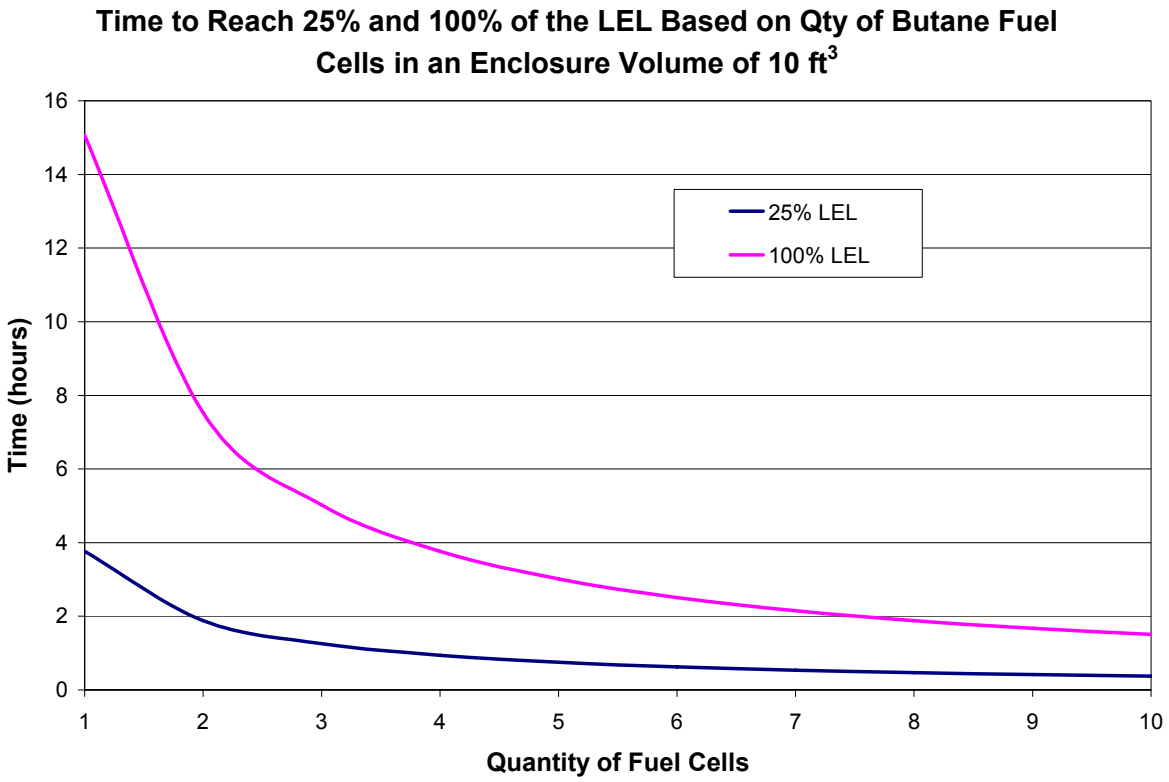
2. ACTION BY THE DGP-WG

2.1 The potential leak of a flammable gas in an aircraft cabin is a serious safety concern. Transport provisions for fuel cell cartridges containing butane are being addressed by the UN Sub-Committee of Experts in a paper submitted by the expert from Canada (see the DGP-WG/06-WP/32, Appendix C). The paper proposes that fuel cell cartridges containing liquefied flammable gas be subjected to a burst test and a production leak test at a no leakage acceptance criteria. Inclusion of provisions to address the leak tightness of cartridges is necessary to assure conformance to aircraft safety standards. The working group members are requested to consider whether any interim measures are necessary to ensure that butane cartridges carried by passengers are sufficiently leak tight.

— — — — — — — —

APPENDIX

CALCULATED LEAK VALUES



Time to Reach LEL (hours)	5.021
Time to Reach 25% of LEL (hours)	1.255

# of Fuel Cells	Time to Reach 25% of LEL (hours)	Time to Reach LEL (hours)		# of Fuel Cells	Time to Reach 25% of LEL (hours)	Time to Reach LEL (hours)
1	3.766222222	15.0648889		6	0.627703704	2.51081481
2	1.883111111	7.53244444		7	0.538031746	2.15212698
3	1.255407407	5.02162963		8	0.470777778	1.88311111
4	0.941555556	3.76622222		9	0.418469136	1.67387654
5	0.753244444	3.01297778		10	0.376622222	1.50648889

— END —